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Tipulodes annae Przybyłowicz, 2003 (Lepidoptera, Erebidae): rediscovery in the wild and citizen science

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Abstract
We report here the rediscovery of *Tipulodes annae* Przybyłowicz, 2003 (Erebidae, Arctiinae), which was originally collected in 1924 and has been unseen and not collected in 84 years, until 2008. We also report this species' first record in Panama and additional localities in Colombia using citizen science platforms. This data is useful information for the conservation of this small moth, and it highlights the importance and utility of citizen science platforms in biodiversity research.

Keywords
Arctiinae, Colombia, Facebook, iNaturalist, Panama, Polilla diablito

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Introduction

Tipulodes Boisduval, 1832 is a small genus of Neotropical moths composed of three species and with a distribution ranging from Panama to Argentina. It is characterized by relatively narrow wings and a rusty-red stripe on the forewings (Przybyłowicz 2001).

This is a very poorly studied genus in the subtribe Ctenuchina, whose relationships between its species and within the subtribe remain unresolved (Rabello 1955). This is probably due to the scarcity of taxonomic information as well as the lack of molecular analysis, despite the review of the genus and the description of *Tipulodes annae* Przybyłowicz, 2003. The description of *T. annae* was based on specimens in the collection of the Natural History Museum, London. The specimens were wrongly identified as belonging to the Zygaenidae since their collection, in 1924, until the species was described by Przybyłowicz (2003).

Citizen science has been considered a powerful tool for improving our understanding of the taxonomy, distribution, and ecology of many species (Mori et al. 2018; Maritz and Maritz 2020; Winterton 2020). This is even more evident since the decline of scientific collections due to decreased popularity and funding (Fischer et al. 2021).

One of the most popular citizen science platforms is iNaturalist, and Facebook is one of the most popular social networks. iNaturalist was launched in 2008 by the California Academy of Sciences and has been doubling its number of observations annually since then, and Irwin (2018) calculated that, up to 2018, scientists have

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used iNaturalist data for more than 150 papers.

The iNaturalist platform has been recognized as a valuable tool for assessing species populations, mainly through species distribution (Chandler et al. 2017). In Latin America, it has been used to track the presence of the invasive ladybird species *Harmonia axyridis* Pallas, 1773 in Argentina (Werenkraut et al. 2020) and Central America (Hiller et al. 2019). But it has also been used to detect diseases, for example in *Rhizophora mangle* Linnaeus, 1753 (Rossi 2017). In Colombia, it has been used to report the new presence of a weasel, *Neogale felipei* Izor & de la Torre, 1978, in the Cordillera Occidental (Roux et al. 2019), and it has added data on the natural history of *Coendou rufescens* (Gray, 1865) (Ramírez-Chaves et al. 2020) and *Toromys rhipidurus* (Thomas, 1928) (Lozano-Flórez et al. 2020). iNatualist has increased its use among both citizens and scientists.

We have used both platforms in the search for information and photographs of *T. annae* with our aim to identify new localities and collect the greatest possible amount of information.

Methods

iNaturalist. The iNaturalist observations were reviewed manually, by first searching and reviewing the subtribe (Ctenuchina) and then the genus (*Tipulodes*). Our review was focused on Colombia, Panama, and Venezuela. Records of the target species were corroborated and refined by sending private messages to the observers. We also requested permission to use both the photographs and data.

Facebook. We organized two "buscatón" (intensive searches) on Facebook. We publicly posted posters with photographs of *Tipulodes annae* and our contact information on popular Colombian insect Facebook groups. We intended to reach other users who had additional records of the species (Fig. 1). We have also reviewed the

Missisipi Entomological Museum
5 mm
POLILLA DIABLITO
Tipulodes annae
Si me ves,
Contáctanos
Encontrada por primera vez en una gaveta olvidada, re-descubierta en un país diferente y vista por última vez en una gran urbe, ésta es Tipulodes annae. Con tu ayuda podremos seguir contando esta maravillosa historia.
Si la ves, o crees verla, tómale una foto, añádele el nombre del sitio y envíanosla al siguiente contacto. Toda ayuda es valiosa para llenar esta página del libro de la vida. GRACIAS
Foto: Edwin Hurtado
@julianbiol
email: julian.alzate1@udea.edu.co
apoya:
Corporación SalvaMontes

Figure 1. Poster used for the "buscatón" and shared on Facebook. With this poster we encouraged people to contacted us when they saw *T. annae* individuals or visually similar moths.

photographs obtained from Facebook contacts to corroborate these records. We requested permission to upload these species photographs as observations on iNaturalist, using the CC BY-NC 4.0 license (https://creativecommons.org/licenses/by-nc/4.0/), which is accepted by GBIF for the incorporation of the data from iNaturalist (GBIF 2021a).

GBIF (Global Biodiversity Information Facility). We reviewed the *Tipulodes* records on GBIF, using "*Tipulodes*" and "*Tipulodes annae*" as search terms. When photographs were available, we confirmed that they represented *T. annae* (GBIF 2021b).

Climate analysis. Climate data were gathered, wherever possible, for the localition of each record of *T. annae*. We reviewed the available data provided by the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) for monthly and annual precipitation in Colombia between 1981 and 2010. Due to the lack of climatic stations above 50 m a.s.l. in the Panamanian region of the Darien, we only use the meteorological information provided by Inrenare and Ancon (1988). Similarily, the municipality of Campamento, Colombia, also lacks of meteorological stations, but we used the nearest station, which was at Anorí 20 km northeast. Anorí and Campamento are both within the Premontane Wet Forest life zone (Pm-wf) (Holdridge 1967). All climatic information was lacking from El Banco and Chiriguana during the 1920s when the species was collected there. Nevertheless, according to Etter et al. (2008), the region was already highly transformed at that time, and since then it did not suffer major changes. Therefore, we assume that the climate did not change significantly until after the 1920s .

Results

New records. COLOMBIA – **Antioquia department** • Campamento; 06.9777, −075.2955, 1700 m a.s.l., 5.X.2019, Julián Alzate obs.; under a streetlight; 1 individual ♀ • as previous but 26.I.2020; 1 individual ♀ • as previous but 30.I.2021; 1 individual ♂ • Carepa 07.7575, −076.6613; 33 m a.sl.; 27.VII.2021; Camilo Zambrano obs.; resting on a wall; 1 individual♀ • Medellín 06.2573, −075.5376; 2000 m a.s.l.; 15.I.2021; Edwin Hurtado obs., resting on a wall; 1 individual ♀ • Peque; 07.0262, −075.9346; 1500 m a.s.l., 26.I.2019; Anderson Mesa Correa obs.; resting on a wall; 1 individual, sex undetermined • Puerto Nare; 06.0526, −074.6645; 146 m a.s.l., 22.III.2021; Santiago Mejía Dugand obs.; resting on a wall; 1 individual ♂ – **Caldas department** • Norcasia; 05.6707, −074.7766; 200 m a.s.l., 26.XII.2008; Ana Jaramillo obs., resting on a wall, 1 individual ♀ • as previous but 02.II.2009.

PANAMA – **Darien province** • 07.9965, −077.7120, 675 m a.s.l., 10.II.2015; John MacDonald, in a light trap, 1 individual ♀, Mississippi Entomological Museum (MEM) 340217 • as previous but 03.II.2017; 1 individual ♀, MEM 340216.

Published records. COLOMBIA – **Cesar Department** • Lake Sapatoza region [sic], Chiriguana District; VIII–IX.1924; C. Allen leg.; 1 ♂, holotype, The Natural History Museum, London, UK (BNHM) NMHUK010920603, 3 ♀, paratypes, NHMUK010920604, NHMUK010920607, NHMUK010920608 (Przybyłowicz 2003) – **Magdalena department** Magdalena Valley, El Banco; 1924; C. Allen leg., 3 ♀,paratypes, BNHM NMHUK010920605, NHMUK010920606 (Przybyłowicz 2003).

Identification. We identified the species using the description, key, and figures by Przybyłowicz (2003). This species is easily recognized by the red mesonotum and the red basal portion of the costae. In the two other *Tipulodes* species, both the mesonotum and the entire costae are dark ochraceous. *Tipulodes annae* also seems to be the only species of its genus with a trans-Andean distribution.

Geographical distribution. Our searches have uncovered 11 records; most are from Colombia, but two are from Panama, and these are the first records of the species from that country, and the first time that the genus *Tipulodes* has been shown to be in Central America. In Colombia, *T. annae* is now known from the Andean (n = 5), Uraba Gulf (n = 1), and Magdalena Valley (n = 3) regions. In Panama, it is now known from the Choco-Darien region (n = 2) (Fig. 2).

Precipitation. We found a correlation between observations of *T. annae* and drier seasons at almost all localities. Four records were found during the transition period between dry and wet seasons at Campamento (October, January), Chiriguana, El Banco (August–September), and Carepa (July). The rest of the observations were made during the dry season. We did not find any observations of *T. annae* during the peak wet seasons.

Discussion

We found six individuals of *Tipulodes annae* using iNaturalist (n = 2) and Facebook (n = 4). These citizen science and social network records are the first observation of this species in over 80 years. Two individuals were found via GBIF in the collection of the Mississippi Entomological Museum where they had been identified as *Tipulodes* sp.

The rediscovery in the wild of *T. annae* is a step forwards in the knowledge and conservation of the species, bringing new information on its distribution. The discovery of seven new localities for the species means that its distribution is wider than previously known. Remarkably, almost all of the individuals were found by citizen scientists, here meaning users of both the iNaturalist and Facebook platforms. This demonstrates that these tools can be very complemental to the distributional data available from natural history collections, as mentioned by Hochmair et al. (2020). The occurrence of *T. annae* near human populations was expected, as iNaturalist and Facebook would be expected to induce this bias

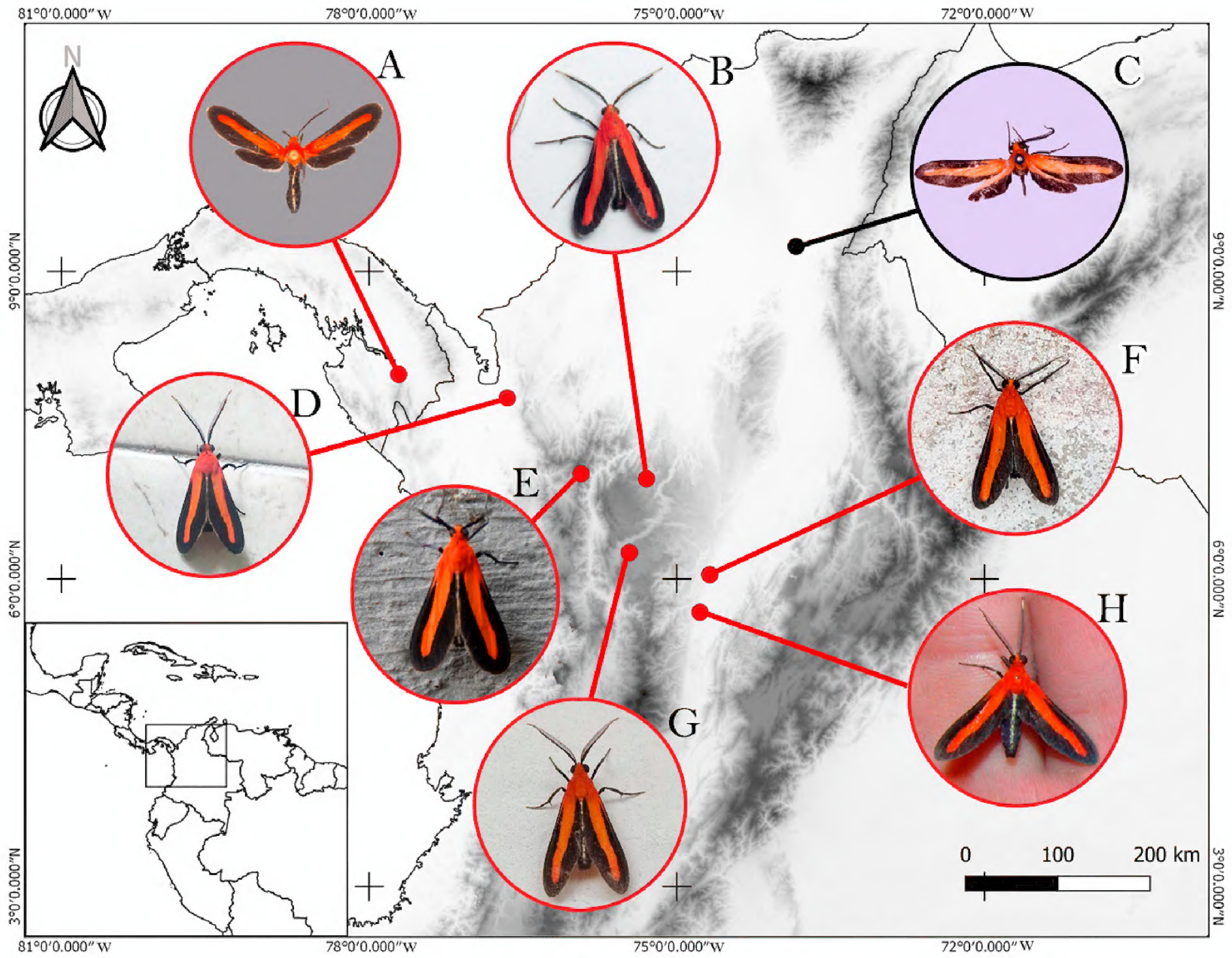

Figure 2. Localities where *Tipulodes annae* has been recorded. The new observations (red) and the type locality (black). Photographs are of a single voucher specimen from each locality. **A.** Darien National Park, Panama (photo: Mississippi Entomological Museum. **B.** Campamento, Colombia (photo: Julian Alzate). **C.** Type locality, Chiriguana, Colombia (photo: Łukasz Przybyłowicz). **D.** Carepa, Colombia (photo: Camilo Zambrano). **E.** Peque, Colombia (photo: Anderson Mesa). **F.** Puerto Nare, Colombia (photo: Santiago Mejia). **G.** Medellín, Colombia (photo: Edwin Hurtado). **H.** Norcasia, Colombia (photo: Ana Jaramillo).

(Maritz and Maritz 2020). Those lack of museum records of *T. annae* may be due to the tiny size of this moth, not because it has a small geographic distribution

Most of the previous records of *Tipulodes* species are from lowlands, and we thought that *T. annae* could have a similar pattern of distribution. However, at least half of the new records were from mountainous regions above 1000 m, and one of them is near 2000 m a.s.l. These records expand the altitudinal distribution of *T. annae* and indicate that this species inhabits a wider variety of ecosystems than previously known. The Medellin record from the second largest city in Colombia suggests that this species may be tolerant to human disturbance. The Panamanian record opens the possibility of a Chocoan–Centro American distribution, but we need further information to corroborate this.

Based on what data we have, *T. annae* seems to have two broods annually. Adults emerge in the transition period between wet and dry seasons and remain alive until the start of the next wet season. Studies focused on the species' life cycle are needed.

Despite its tiny size, this moth could be an emblematic species due to its jazzy colors. We propose the Spanish common name, "Polilla diablito" ("Little-devil moth" in English), which has strong implications in Latin American folklore due to regional religious traditions and the fundamental role that the devil plays in Christian culture (Taussig 2010).

Even though citizen science can be a very helpful tool, it cannot replace museum collections and more information is needed, including its seasonality, geographic distribution, and morphological characteristics (some male genital characters remain unknown). We suggest further exploration in the mountainous regions of the Cordillera Oriental, the Pacific Coasts of Colombia and Ecuador, and the wet forests of Panama. Entomological collections in Colombia require extensive curation and revisionary work, especially among the noctuoids, and anticipate that more specimens of *T. annae* exists in these collections.

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